

AD-A040 647

ARMED FORCES FOOD SCIENCE ESTABLISHMENT SCOTTSDALE (A--ETC F/G 6/8
THE EFFECT OF VARIETY ON DEHYDRATION AND LONG TERM STORAGE OF C--ETC(U)
DEC 76 G E DRIVER, S VENKATA-RAMAN
AFFSE-2/76

UNCLASSIFIED

NL

1 OF 1

AD
A040647



END

DATE
FILMED

7-77

ADA 040647

UNCLASSIFIED

AFFSE REPORT 2/76 ✓

AR No. 000499



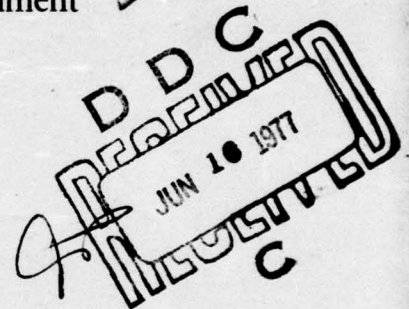
Department of Defence

Defence Science and Technology Organisation

Armed Forces Food Science Establishment ✓

Scottsdale, Tasmania

AFFSE REPORT 2/76



© COMMONWEALTH OF AUSTRALIA. 1976

The Effect of Variety on Dehydration
and Long Term Storage of
Carrots (*Daucus carota*) (U)



G. E. DRIVER and S. VENKATA-RAMAN

AD No. 040647
DDC FILE COPY

APPROVED
FOR PUBLIC RELEASE

Commonwealth of Australia
December, 1976

THE UNITED STATES' NATIONAL
TECHNICAL INFORMATION SERVICE
IS AUTHORIZED TO
REPRODUCE AND SELL THIS REPORT

APPROVED
FOR PUBLIC RELEASE

UNCLASSIFIED

DEPARTMENT OF DEFENCE

ARMED FORCES FOOD SCIENCE ESTABLISHMENT ✓

(14) AFFSE REPORT - 2/76 ✓

(9) Technical rept,

(6) THE EFFECT OF VARIETY ON DEHYDRATION AND LONG TERM
STORAGE OF CARROTS (DAUCUS CAROTA). (U)

(10) G.E./DRIVER and S./VENKATA-RAMAN

(C) COMMONWEALTH OF AUSTRALIA, 1976

(11) Dec 76

(12) 16p.

ACCESSION for	
RTS	Write Section <input checked="" type="checkbox"/>
DDC	Soft Section <input type="checkbox"/>
UNANNOUNCED	<input type="checkbox"/>
JUSTIFICATION	
BY	
DISTRIBUTION/AVAILABILITY CODES	
Dist.	AVAIL. CODE/yr 1976-80
A	

S U M M A R Y

Twelve carrot varieties were analysed for reducing and total sugars, carotene and solids content. Samples of certain varieties were dehydrated and stored at 1, 15 and 37°C for up to two years and subjected to taste panel testing at intervals. Browning was determined after storage at 37°C for 2 yr and found to depend markedly on moisture and reducing sugar content. Recommendations of varieties suitable for dehydration and long term storage are made. (U)

POSTAL ADDRESS:

The Director,
Armed Forces Food Science Establishment,
P.O. Box 147,
Scottsdale, Tasmania, 7254.

APPROVED

FOR PUBLIC RELEASE

410 231

LB

DOCUMENT CONTROL DATA SHEET

Security classification of this page

- | | |
|--|--|
| <p>1. DOCUMENT NUMBERS</p> <p>a. AR Number: 000499</p> <p>b. Document Series and Number: -</p> <p>c. Report Number: 2/76</p> | <p>2. SECURITY CLASSIFICATION</p> <p>a. Complete document: Unclass</p> <p>b. Title in isolation: Unclass</p> <p>c. Summary in Isolation: Unclass</p> |
|--|--|
-
3. TITLE: The Effect of Variety on Dehydration and Long Term Storage of Carrots (Daucus Carota)
-
- | | |
|---|---|
| <p>4. PERSONAL AUTHOR(S):</p> <p>DRIVER, Graham E.</p> <p>VENKATA-RAMAN, S.</p> | <p>5. DOCUMENT DATE:</p> <p>November, 1976.</p> |
|---|---|
-
- | | |
|--|--|
| <p>7. CORPORATE AUTHOR(S):</p> <p>Armed Forces Food Science Establishment,
Scottsdale, Tasmania, Aust.</p> | <p>6. TYPE OF REPORT AND PERIOD COVERED:</p> <p>Technical Report</p> |
|--|--|
-
- | | |
|---|--|
| <p>10. IMPRINT (Publishing establishment):</p> <p>AFFSE - December, 1976.</p> | <p>8. REFERENCE NUMBERS</p> <p>a. Task: FSE 76/036</p> <p>b. Sponsoring Agency: DOD (Army)</p> |
|---|--|
-
9. COST CODE: 241
-
- | | |
|--|--|
| <p>12. RELEASE LIMITATIONS (of the document):</p> <p>Approved for public release</p> | <p>11. COMPUTER PROGRAM(S)</p> <p>(Title(s) and language(s))</p> <p>-</p> |
|--|--|
-
- 12-0. OVERSEAS: N.O. ☐ P.R. ☐ 1 ☐ A ☐ B ☐ C ☐ D ☐ E ☐
-
13. ANNOUNCEMENT LIMITATIONS (of the information on this page):
-
- | | |
|---|---|
| <p>14. DESCRIPTORS:</p> <p>CARROTS, ROOT CROPS, CAROTENE</p> <p>HOT AIR DEHYDRATION, SHELF LIFE</p> | <p>15. COSATI CODES:</p> <p>0608-0204</p> |
|---|---|
-
16. SUMMARY (if this is security classified, the announcement OR ABSTRACT of this report will be similarly classified):
- Twelve carrot varieties were analysed for reducing and total sugars, carotene and solids content. Samples of certain varieties were dehydrated and stored at 1, 15 and 37°C for up to two years and subjected to taste panel testing at intervals. Browning was determined after storage at 37°C for 2 yr and found to depend markedly on moisture and reducing sugar content. Recommendations of varieties suitable for dehydration and long term storage are made. (U)

UNCLAS

(Security classification of this page)

C O N T E N T S

	<u>Page No.</u>
Introduction	1
Methods	1
Results and Discussion	2
Conclusion	4
Acknowledgement	5
Tables and Figures	6-11
References	12
Distribution List	

THE EFFECT OF VARIETY ON DEHYDRATION AND LONG TERM

STORAGE OF CARROTS (DAUCUS CAROTA)

by

G.E. Driver and S. Venkata-Raman

Carrots are dehydrated in large quantities throughout the world for use as a vegetable and as a component in dehydrated composite meals and soup mixes. Dehydrated carrots store well apart from some oxidation of carotenes resulting in loss of vitamin A activity and production of off odours. Non-enzymic browning results in off flavours and odours and discolouration. Oxidation is a special problem in freeze-dried carrots because of the low moisture content and high porosity, while hot air dried carrots will be more susceptible to non-enzymic browning.

Carrots cultivars including several new hybrids, were made available from a trial conducted at the Forthside Vegetable Research Farm of the Tasmanian Department of Agriculture, and their suitability for dehydration determined.

METHODS

Carrots were grown at the Forthside Vegetable Research Farm in a randomised block design with two replicates and harvested at 180 days. At 130 days, samples of each variety were removed from between plot buffer zones for initial chemical analysis, and on the results of these analyses and general observations of shape, size and defects, eight varieties were chosen for dehydration trials.

Carotene Estimation

Approximately 10 g of grated carrots were accurately weighed and extracted for 15 min with 50 ml of refluxing ethanol. The solids were filtered from the extract using a sintered glass funnel and washed with small portions of ethanol. Solids were re-extracted with 25 ml portions of the solvent till almost colourless.

The combined alcoholic extracts were added to petroleum spirit (50 ml b.p. 40-60°C) and water (150 ml) added, the aqueous layer being separated and extracted with 20 ml portions of petroleum spirit till extracts were colourless. The combined extracts were then washed with five 50 ml portions of water, filtered through anhydrous sodium sulphate and made up to 200 ml with petroleum spirit. The absorbance was measured at 445 nm against a solvent blank, using 10 mm cells on a Pye Unicam SP 500. Calibration was with β -carotene (Koch-Light "puriss") dissolved in petroleum spirit.

Sugar Content

Sugars were extracted from grated carrots by boiling for 1 hr, with 80 ml of 80% alcohol (neutralized with CaCO_3) and the extract

made to 100 ml. Fifty millilitres of this solution was evaporated almost to dryness, taken up in water and clarified using lead acetate (AOAC, 1965 a) and made to 200 ml. Reducing sugars in the clarified extract were determined by the Shaffer-Somogyi Method (AOAC, 1965 b).

A 50 ml aliquot of the clarified extract was hydrolysed overnight at 37°C by the addition of 3 ml of hydrochloric acid. The hydrolysate was neutralised by the addition of solid sodium carbonate and the solution made to 100 ml. Total reducing sugars after inversion ("total sugars") were determined by the Shaffer-Somogyi Method (AOAC, 1965 b).

Dehydration

Carrots were peeled by hand and diced to 8 mm cube using a Halde slicer-dicer, and blanched in atmospheric steam for 5 minutes₂ (timed from the exhaust reaching 90°C) at a tray loading of 18 kg/m². The carrots were sprayed with a solution of sodium metabisulphite to give 500-1000 ppm sulphur dioxide in the dehydrated product.

Dehydration was carried out to 80°C for 5 hr followed by overnight drying at 60°C in a laboratory cross-flow dehydrator, at a loading density of 8 kg/m². Samples were vacuum packed in polyester/polyethylene/foil/polyethylene laminated pouches at 7 kPa and stored at 37°C, 15°C and 1°C.

Organoleptic Evaluation

Carrots were taste tested fresh after cooking in simmering water for 15 min, and after rehydration by simmering in excess water for 30 min. A panel rated the carrots for appearance, texture, flavour (aroma and taste) and overall acceptance, on a nine point hedonic scale, "nine" being "like extremely" and "one" representing "dislike extremely".

Estimation of Browning

Browning was estimated according to the method of Baloch et. al (1973).

RESULTS AND DISCUSSION

Results of analysis of fresh carrots are shown in Table 1. Total solids were in the range of 10-13% with Hybrid NC x 6006 being by far the highest at 12.8% solids. A high total solids content is desirable because of economies in operation. These values are low, other reports indicating solids contents of up to 18% (Fairbrother, 1968). Solids content will depend on seasonal and cultural conditions and on maturity at harvest.

'Redbank' had a low solids content of 9.93% making it unsuitable for dehydration.

Carotene contents are shown as $\mu\text{g/g}$ on a fresh weight as well as on total solids basis. There is little difference in the two methods of expressing results with the major change in ranking being for 'Redbank', which on a fresh-weight basis is ranked tenth, but on a dry weight basis is ranked sixth. Hybrid NC x 6006 has a ranking of twelve (lowest content) under both methods of expressing results but because of its higher solids content than other varieties, the carotene content expressed on a dry weight basis is proportionately less.

Carrots contain negligible amounts of protein and have a calorific value of about 150 kJ/100g. Their main attribute apart from adding variety and colour to meals is their high vitamin A activity which they share with liver and yellow or green vegetables (e.g. pumpkin, silver beet and broccoli). β -carotene content is therefore important, but all varieties contained sufficient quantities although it must be recognised that the figures in Table 1 include other carotenes which are extracted and estimated along with β -carotene but which have lower vitamin A activity. Baloch (1976) found that approximately 68% of the total carotenes of raw carrot was β -carotene.

Of importance and related to β -carotene content is carrot colour, particularly that of the core, a uniform orange colour being desired. All varieties had suitable colour throughout.

Reducing sugar content varied from 1.18 to 2.68% on a fresh weight basis. This was considered important as it is reducing sugars that are mainly responsible for non-enzymic browning in stored dehydrated foodstuffs resulting in discolouration and off odours. To obtain some idea as to the effect of reducing sugar content, varieties chosen for dehydration included those with high and low reducing sugar contents.

Total reducing sugars after inversion varied from 5.13 to 7.11% on a fresh weight basis. It was thought that high total sugar content may lead to high ratings for flavour, but there were no significant differences between flavour scores of the fresh and cooked carrot (Table 2).

Dehydrated Carrot

Results of organoleptic testing of dehydrated carrots are shown in Table 2. Samples stored at 1°C or 15°C were quite acceptable after two years storage if vacuum packed. Carrots contained in pouches that had lost vacuum were still rated acceptable by the taste panel.

The large apparent change in average scores between 18 and 24 months storage is probably due to changes in taste panel composition rather than sudden deterioration of samples.

From the taste testing it is apparent that there are differences between replicate plots after storage for two years at 37°C (e.g. plots 6 and 20) and no satisfactory explanation for this is apparent.

Rate of browning is very dependent on moisture content, as shown by determination of browning after two years storage at 37°C, and shown in Figure 1 and Table 3. A change in moisture from 1.5 to 2.2% approximately doubles the browning over this storage period, but all samples stored for this time were considered inedible by the taste panel (rated as "dislike slightly" or "rather poor" for flavour and overall acceptability) even though the moisture levels attained were well below those usual for a commercial product. Feinberg *et. al.* (1964) report a moisture content of 3.5 to 4.5% as typical for dehydrated carrot, compared with 1.5 to 2.3% for the present samples.

As storage temperature is increased, water activity increases (at constant moisture content) and so the rate of browning increases more rapidly with rising temperature than would be predicted solely on the basis of energy of activation of the browning reaction.

Reducing sugar content is known to be important in non-enzymic browning of dried potato products (Burton, 1945). That reducing sugar content affects the browning of dried carrot is clearly shown in Figure 2, and by the partial correlation coefficient of browning and reducing sugar content of 0.775 (at constant moisture).

Total reducing sugar content and browning also have a positive correlation (Table 3) although this is not significantly different from zero. This may be due to hydrolysis of non-reducing sugars to reducing sugars during storage, as Karel and Labuza (1968) have shown that sucrose is hydrolysed by organic acids in model systems and at extremely low moisture levels of below 1% and below the BET monolayer value for the system.

Multiple correlations of browning with moisture and reducing and total sugar contents are shown in Table 4. All correlations are significantly different from zero, but addition of the second or third variable does not cause a significant increase in the correlation.

C O N C L U S I O N

It was found that the deterioration of hot air dried carrots increased rapidly with increasing reducing sugar and moisture contents. Moisture content is affected directly by processing conditions, but reducing sugar content will be determined by carrot variety, growing conditions and maturity.

Varieties with low reducing sugar contents were Hybrid NC x 6006 (Niagara), Lance (Dessert), D447A x D308B (Dessert) and Touche (Dessert). All these varieties had good solids content with Hybrid NC x 6006 having the highest (12.77%) recorded during this experiment, but only D447A x D308B had the conical shape, most suitable for mechanical peeling, the others being more cylindrical.

These varieties would be the most suitable for dehydration and

high temperature storage, and it would seem that varieties with high solids but low reducing sugar content should be sought.

A C K N O W L E D G E M E N T

We thank Mr. B. Beattie of the Tasmanian Department of Agriculture for providing samples of carrot cultivars used in the trial.

Mr. D. Rotgans assisted with taste panel testing which is gratefully acknowledged.

Table 1. Total solids, carotene, reducing sugar and reducing sugar after inversion contents of carrot varieties.

VARIETY	SOURCE	SOLIDS (%)	β -CAROTENE ($\mu\text{g/g}$) FRESH WT SOLIDS	REDUCING SUGARS (% FRESH WT)	TOTAL SUGARS (% FRESH WT)	COMMENTS
A. Swamp King	Local	11.08	40	2.20	6.84	Truncate or conical
B. Redland	New World	10.65	48	2.04	5.81	Conic
C. Royal Chantenay	New World	10.99	38	-	5.97	Conic, bent and furrowed
D. Hybrid NCx6006	Niagara	12.77	29	1.32	7.11	Long taper
E. Dess-Dan	Dessert	11.80	53	1.77	6.45	Conic or truncate
F. D306AxM9541C	Dessert	11.87	52	1.67	6.22	Conic
G. Lance	Dessert	11.80	42	1.41	5.79	Cylindrical
H. D447AxOSU14362	Dessert	11.19	62	1.79	5.46	Conic
J. D447AxD308B	Dessert	11.68	47	1.18	6.42	Conic, variable size
K. Swamp King	Yates	10.54	32	2.68	5.92	Extreme conical
L. Touche	Dessert	11.46	42	1.46	6.59	Conic-cylindrical, variable size
M. Redbank	Yates	9.93	36	2.39	5.13	Conic

Table 2 Average taste panel scores* for fresh and stored, dehydrated carrot varieties.

VARIETY	PLOT	STORAGE CONDITIONS												
		FRESH	6 mths at 1°C	6 mths at 37°C	18 mths at 37°C	24 mths at 1°C	24 mths at 15°C	24 mths at 37°C						
A A D D E F G H H J J K L	1 23 2 13 12 9 5 3 21 6 20 4 11	6.9 - 7.0 - 7.0 7.3 7.1 7.0 - 7.0 - 6.7 7.0	(a)	<u>APPEARANCE</u>	4.6	5.8 6.1 - - 6.1 - - 7.0 6.3 7.1 - 6.6	2.7 3.0 - 4.3 3.1 3.3 3.2 4.2 3.0 2.7 2.0 2.4 2.3							
				6.2 6.0 - 6.0 6.4 5.8 6.6 6.4 6.1 6.2 6.4 6.0 6.3	4.5 5.2 - 5.6 5.1 5.8 5.6 6.1 4.9 5.6 5.6 5.1 5.6	- 4.6 - - - 4.6 - - 4.9 4.9 3.7 -								
				A A D D E F G H H J J K L	1 23 2 13 12 9 5 3 21 6 20 4 11	7.0 - 7.0 - 6.9 7.0 6.7 7.0 - 6.9 - 7.0 6.9	(b)	<u>TEXTURE</u>	4.4	6.5 5.1 - - 5.3 - 6.4 5.4 7.0 - 6.3	5.3 3.4 - 5.8 4.8 3.3 5.3 5.3 3.3 4.0 3.4 4.3 3.6			
								5.7 5.9 - 5.5 6.0 5.7 6.7 6.4 5.9 5.4 6.1 6.0 5.9	5.3 5.4 - 5.1 5.5 5.7 6.3 6.1 5.4 5.3 5.9 5.4 5.9	- 4.4 - - - 5.7 - 4.9 6.0 4.3 -				
							/Con't						

.... / Con't

Table 2 (Continued)

VARIETY	PLOT	STORAGE CONDITIONS						
		FRESH	6 mths at 1°C	6 mths at 37°C	18 mths at 37°C	24 mths at 1°C	24 mths at 15°C	24 mths at 37°C
A A D D E E F G H H J J K L	1	7.0	5.3	(p) FLAVOUR 4.7	-	5.7	-	3.3
	23	-	5.6	5.3	5.1	4.9	-	2.5
	2	6.6	-	-	-	-	-	-
	13	-	5.3	5.3	-	-	5.3	3.7
	12	6.9	6.0	5.3	-	-	5.9	3.6
	9	6.9	5.5	5.5	-	5.3	-	2.8
	5	6.9	6.0	5.7	6.0	-	7.0	3.7
	3	6.7	6.1	6.0	-	-	6.3	3.3
	21	-	6.2	5.2	-	5.6	-	2.7
	6	6.7	5.6	4.4	5.0	6.1	-	3.4
	20	-	5.9	5.4	6.0	6.7	-	2.7
	4	6.7	5.9	5.3	4.4	-	-	3.1
	11	6.6	5.8	5.6	-	6.3	-	2.9
				(s) OVERALL ACCEPTABILITY				
A A D D E E F G H H J J K K	1	6.3	5.3	4.7	-	6.5	-	3.0
	23	-	5.4	5.6	5.0	5.0	-	2.5
	2	6.7	-	-	-	-	-	-
	13	-	5.5	5.1	-	-	5.4	3.7
	12	6.9	6.1	5.3	-	-	5.8	3.1
	9	6.6	5.2	5.3	-	5.1	-	2.6
	5	6.6	6.1	5.7	5.6	-	7.0	3.5
	3	6.7	6.3	6.0	-	-	6.3	3.5
	21	-	6.0	5.0	-	5.4	-	2.6
	6	6.9	5.6	4.5	4.9	5.9	-	3.1
	20	-	5.8	5.3	5.9	6.7	-	2.4
	4	6.7	5.7	5.3	4.3	-	-	2.6
	11	6.6	5.8	5.6	-	6.0	-	2.6

* Hedonic scale 1 to 9: dislike extremely to like extremely.

Table 3

Moisture content and browning of
dehydrated carrot, after two years
storage at 37°C

SAMPLE (VARIETY)	H ₂ O (%)	REDUCING SUGARS (% SOLIDS)	TOTAL SUGARS (% SOLIDS)	BROWNING (A420-600)
1 (A)	2.32	19.9	61.7	0.207
3 (H)	1.82	16.0	48.8	0.074
4 (K)	1.67	25.4	56.2	0.216
5 (G)	1.83	11.9	49.1	0.091
6 (J)	1.62	10.1	55.0	0.099
9 (F)	1.88	14.1	52.4	0.123
11 (L)	2.25	12.7	57.5	0.197
12 (E)	1.89	15.0	55.7	0.127
13 (D)	1.61	10.3	54.7	0.087
20 (J)	1.81	10.1	55.0	0.075
21 (H)	1.55	16.0	48.8	0.088
23 (A)	1.61	19.9	61.7	0.133

Table 4 Correlation of browning with water and sugar contents of dehydrated carrot

$\sqrt{12.3}$	=	0.717*	
$\sqrt{13.2}$	=	0.775**	
$\sqrt{14.32}$	=	0.498 ^{NS}	
$\sqrt{1.2}$	=	0.565 ^{NS}	$X_1 = 0.12 X_3 - 0.092$
$\sqrt{1.3}$	=	0.662**	$X_1 = 0.0073 X_3 + 0.015$
$\sqrt{1.23}$	=	0.853***	$X_1 = 0.114 X_2 + 0.0071 X_3 - 0.189$
$\sqrt{1.234}$	=	0.892***	$X_1 = 0.092 X_2 + 0.0059 X_3 + 0.0036 X_4 - 0.327$

- 1 Browning
- 2 % Moisture dehydrated product
- 3 Reducing Sugars as % of Solids
- 4 Total sugars after inversion as % of solids

NS not significant P = 0.05

* significant at P = 0.005

** significant at P = 0.01

*** significant at P = 0.001

Figure 1 Correlation of browning with moisture content.

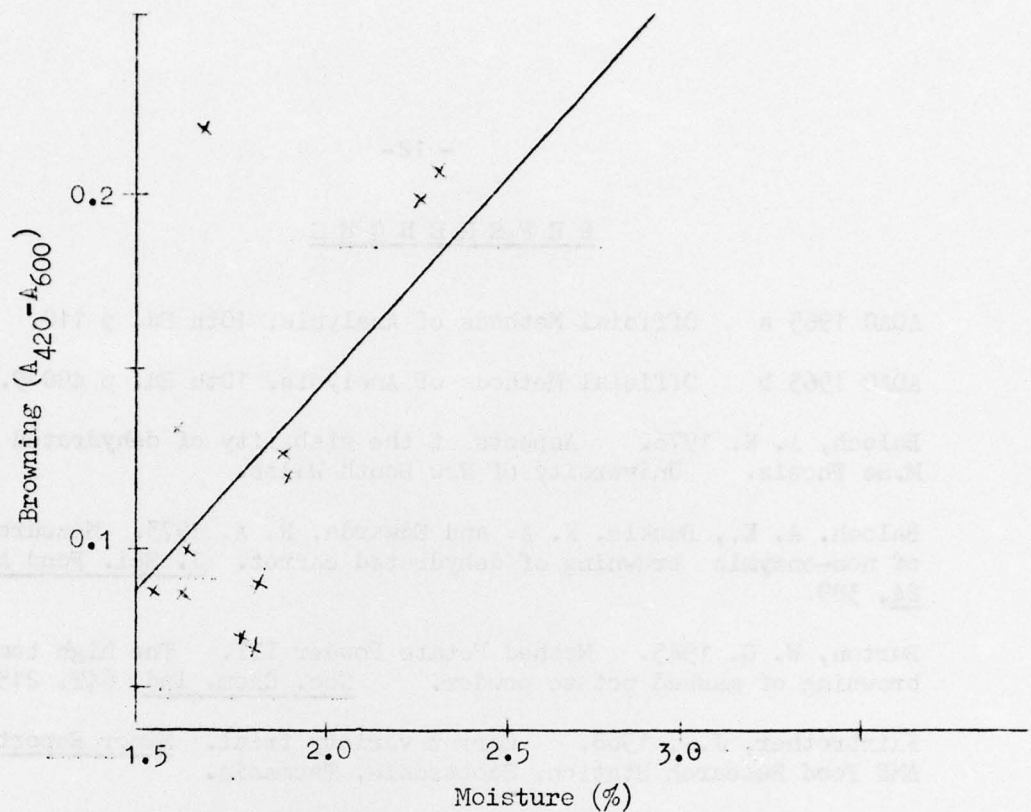
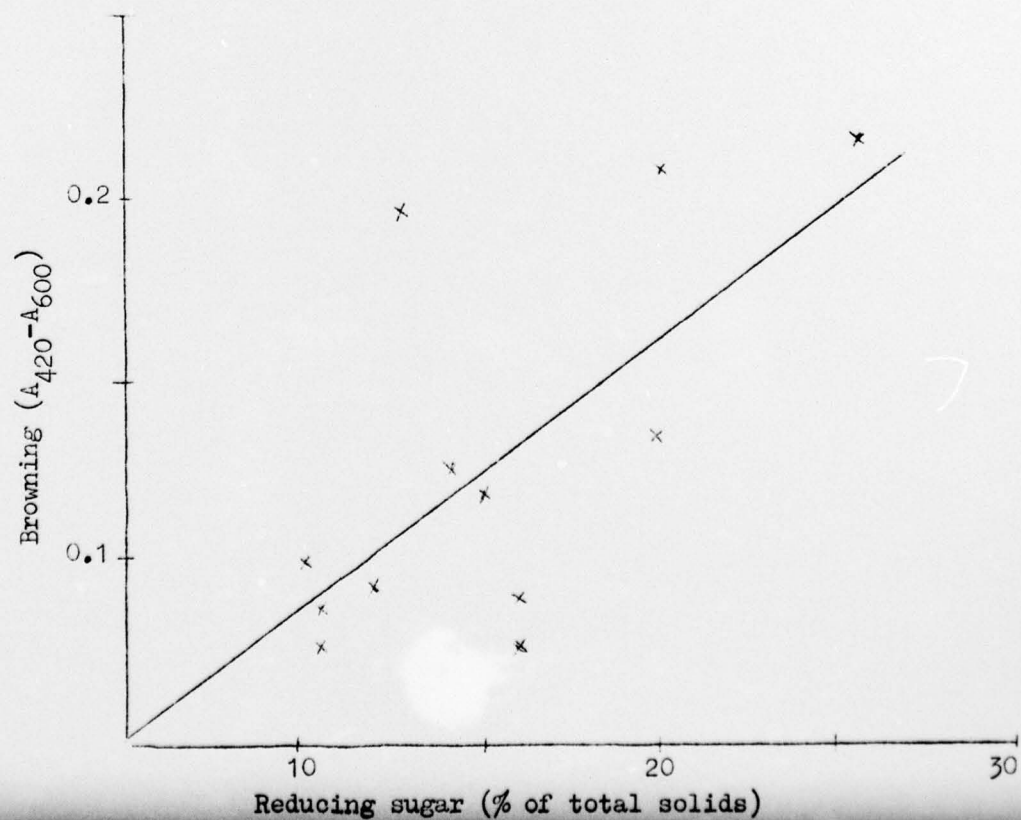


Figure 2 Correlation of browning with reducing sugar content



REFERENCES

- AOAC 1965 a Official Methods of Analysis, 10th Ed. p 110.
- AOAC 1965 b Official Methods of Analysis, 10th Ed. p 498-9.
- Baloch, A. K. 1976. Aspects of the stability of dehydrated carrots.
M.Sc Thesis. University of New South Wales.
- Baloch, A. K., Buckle, K. A. and Edwards, R. A. 1973. Measurement
of non-enzymic browning of dehydrated carrot. J. Sci. Food Agric.,
24, 389.
- Burton, W. G. 1945. Mashed Potato Powder III. The high temperature
browning of mashed potato powder. Soc. Chem. Ind. 64T, 215.
- Fairbrother, J.G. 1968. Carrot variety trial. Minor Report MR/33
AMF Food Research Station, Scottsdale, Tasmania.
- Feinberg, B., Schwimmer, S., Reeve, R. and Juilly, M. 1964, in
Food Dehydration Vol II. Product and Technology. Copley and
Van Asdel (Editors). AVI Publishing Co., Westport, Conn. 1964.
- Karel, M. and Labuza, T. P. 1968. J. Agri Food Chem., 16, 717

D I S T R I B U T I O N L I S T

No. of Copies

DEFENCE ESTABLISHMENTS

Department of Defence,
Russell Offices,
CANBERRA. A.C.T. 2600

- | | | |
|-----|---|---|
| (a) | Secretary | 6 |
| (b) | Chief Defence Scientist | 1 |
| (c) | Executive Controller,
Australian Defence Scientific Services | 1 |
| (d) | Controller,
Service Laboratories and Trials | 2 |
| (e) | Mr. R. H. Mathams,
JIO Russell L. | 1 |

Department of Defence (Army Office),
Russell Offices,
CANBERRA. A.C.T. 2600

- | | | |
|-----|----------------------------------|---|
| (a) | Directorate of Army Development | 2 |
| (b) | Director of Infantry | 2 |
| (c) | Director of Catering | 1 |
| (d) | Scientific Adviser (Army Office) | 1 |
| (e) | Librarian,
Central Library | 1 |

Department of Defence (Air Office),
Russell Offices,
CANBERRA. A.C.T. 2600

- | | | |
|-----|--------------------|---|
| (a) | Scientific Adviser | 1 |
|-----|--------------------|---|

Department of Defence (Navy Office),
Russell Offices,
CANBERRA. A.C.T. 2600

- | | | |
|-----|--------------------|---|
| (a) | Scientific Adviser | 1 |
|-----|--------------------|---|

Scientific and Technical Information Branch (STIB),
Department of Defence,
Campbell Park Offices,
CANBERRA. A.C.T. 2601

Director General of Supply,
Department of Defence (Army Office),
G.P.O. Box 1932R,
MELBOURNE. Vic. 3001

DEFENCE ESTABLISHMENTS (Con't) No. of Copies

Headquarters, Supply Division, St. James Plaza, G.P.O. Box 1932R, MELBOURNE. Vic. 3001	2
Director General of Medical Services, Department of Defence (Army Office), St. James Plaza, G.P.O. Box 1932R, MELBOURNE. Vic. 3001	2
The Director of Victualling and General Stores, Department of Defence (Navy Office), Victoria Barracks, St. Kilda Road, MELBOURNE. Vic. 3004	2
Headquarters, Field Force Command, Victoria Barracks, PADDINGTON. N.S.W. 2021	3
Headquarters, Logistic Command, St. James Plaza, G.P.O. Box 1932R, MELBOURNE. Vic. 3001	3
Headquarters, Training Command, Victoria Barracks, PADDINGTON. N.S.W. 2021	3
Headquarters, Support Command RAAF, Victoria Barracks, St. Kilda Road, MELBOURNE. Vic. 3004	1
Headquarters, 1 Military District, Victoria Barracks, BRISBANE. Qld. 4000	1
Headquarters, 2 Military District, Victoria Barracks, SYDNEY. N.S.W. 2000	1
Headquarters, 3 Military District, Victoria Barracks, MELBOURNE. Vic. 3000	1

DEFENCE ESTABLISHMENTS (Con't)

Headquarters, 4 Military District, Keswick Barracks, ADELAIDE. S.A. 5035	1
Headquarters, 5 Military District, Swan Barracks, PERTH. W.A. 6000	1
Headquarters, 6 Military District, Anglesea Barracks, HOBART. Tas. 7002	1
Headquarters, 7 Military District, Larrakeya Barracks, DARWIN. N.T. 5790	1
Commandant, Royal Military College, DUNTROON. A.C.T. 2600	1
Commandant, Army Staff College, QUEENSCLIFFE. Vic. 3255	2
Commanding Officer/Chief Instructor, RAAOC Centre, Milpo, BANDIANA. Vic. 3662	2
Commandant, RAAF Staff College, Royal Australian Air Force Base, CANBERRA. A.C.T. 2600	2
Director, Institute of Aviation Medicine, POINT COOK. RAAF. Vic. 3029	2

CIVILIAN ESTABLISHMENTS

Librarian, CSIRO, Stowell Avenue, HOBART. Tas. 7000	
The Librarian, CSIRO Division of Food Research, Food Research Laboratory, P.O. Box 52, NORTH RYDE. N.S.W. 2113	

CIVILIAN ESTABLISHMENTS (Con't)

Librarian,
CSIRO Dairy Research Laboratory,
P.O. Box 20,
HIGHETT. Vic. 3190 1

Government Analyst,
Department of Science,
CANBERRA. A.C.T. 2600 1

Dr. R. I. Garrod
Department of Education and Science,
P.O. Box 826,
CANBERRA. A.C.T. 2601 1

The Librarian,
Department of Health,
P.O. Box 100,
WODEN. A.C.T. 2606 2

Dr. R. C. Hutchinson,
Derwentlaken Road,
GREGSON. Tas. 7402 1

Head,
Library Department,
Central Library,
Royal Melbourne Institute of Technology,
Floor 1, Casey Wing,
368 Swanston Street,
MELBOURNE. Vic. 3000 1

Officer-in-Charge,
Preparation Branch,
National Library of Australia,
CANBERRA. A.C.T. 2600 2

State Librarian,
State Library of Tasmania,
Murray Street,
HOBART. Tas. 7000 1

Director,
Food Preservation Laboratory,
Department of Primary Industries,
HAMILTON. Qld. 4000 1

Head,
Food School,
East Sydney Technical College,
Forbes Street,
DARLINGHURST. N.S.W. 2010 1

CIVILIAN ESTABLISHMENTS (Con't)

University of New South Wales,
P.O. Box 1,
KENSINGTON. N.S.W. 2033

(a) Head,
Department of Food Technology 1

(b) Librarian,
Serials Department,
Central Library 1

The Medical Library,
Flinders University of South Australia,
BEDFORD PARK. S.A. 5042 1

OVERSEAS ESTABLISHMENTS

BRITAIN

Australian Army Representative,
Australia House,
Strand,
London, WC2, England 2

Ministry of Defence (Navy),
Directorate of Supplies & Transport
(General and Victualling),
Empress State Building,
Lillie Road,
London, SW6, England 2

Adviser in Nutrition,
AMD5, (Army Dept), Ministry of Defence,
Landsdowne House, Berkeley Square,
London, W1, England. 1

Deputy Chief Scientist (Army),
Sag (a) 3D,
Ministry of Defence,
Main Building, Whitehall Gardens,
London SW 1A 2HB, England 2

The Director,
Army Personnel Research Establishment,
C/- Royal Aircraft Establishment,
Farnborough, Hants, England 1

The Information Officer,
British Food Manufacturing Industries
Research Association,
Randalls Road, Leatherhead,
Surrey, England 1

No. of Copies

OVERSEAS ESTABLISHMENTS (Con't)

BRITAIN (Con't)

The Librarian, Food Research Institute, Colney Lane, Norwich NOR 70F, England	1
Superintendent, Foods and Nutrition Division, Laboratory of the Government Chemist, Cornwall House, Stamford Street, London, SE1 9NQ, England	6
The Librarian, Meat Research Institute, Langford, Bristol, England	1
Dr. D. J. McWeeny, Ministry of Agriculture, Fisheries and Food, Food Science Unit, Food Research Institute, Colney Lane, Norwich, Norfolk, NOR 70F, England	1
Mr. J. F. Hearne, Food Standards Science and Safety Division, Ministry of Agriculture, Fisheries and Food, Great Westminster House, Horseferry Road, London, SW1, England	3
The Librarian, National College of Food Technology, University of Reading, St. George's Avenue, Weybridge, Surrey, England	1
The Director, Tropical Products Institute, Gray's Inn Road, London WC1, England	1

CANADA

National Defence Headquarters, Ottawa, Ontario, K1A 0K2.	
(a) Major N.A. Galbraith (DCGE 3-4)	2
(b) D Food S ^c	1
(c) DGOS Technical Library	1

OVERSEAS ESTABLISHMENTS (Con't)

CEYLON

Director,
Food Research and Nutrition Council,
C/- Food Commissioner,
Union Place, Colombo, Ceylon 1

GERMANY

Armed Services Food Chemist,
89 Supply Depot RAOC,
Viersen, Germany, BFPO 40. 1

GHANA

Defence Adviser,
Office of the High Commission for Ghana
13 Belgrave Square,
London SW1, England 1

INDIA

Director General,
Research and Development Organisation,
Ministry of Defence,
New Delhi, 11 2

The Director,
Defence Food Research Laboratory,
Jyothi Nagar, PB No. 45
Mysore - 1, India 2

MALAYSIA

Director, Defence Research Centre,
Ministry of Defence,
Rifle Range Road,
Kuala Lumpur, Malaysia 3

Director of Supplies and Transport,
Ministry of Defence,
C/- G.P.O. Kuala Lumpur 1

NEW ZEALAND

Chief Scientist,
Defence Science Organisation, DSIR,
P.O. Box 8010,
Wellington, New Zealand 1

No. of Copies

OVERSEAS ESTABLISHMENTS (Con't)

PAPUA NEW GUINEA

Australian Defence Headquarters Co-operation
Group,
P.O. Box 2270,
Kongdabu, Papua New Guinea

3

PHILIPPINES

Science Research Supervisor,
Food Research Division,
Food & Nutrition Research Institute,
Manila, Philippines

1

UNITED STATES OF AMERICA

Chief, Food and Nutrition Section,
NASA - Manned Spacecraft Center,
Houston, Texas

1

Director,
U.S. Army Natick Laboratories,
Food Laboratory,
Natick, Massachusetts, U.S.A.

2